EMC

Executive Summary

of

ENERGY ENGINEERING ANALYSIS (EEA) PROGRAM

for

Ft. McCoy, Wisconsin

DISTRIBUTION STATEMENT A
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Prepared for

United States Army District, Omaha
Corps of Engineers
Omaha, Nebraska

Under

Contract No. DACA 45-80-C-0028

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Prepared by

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Denver, Colorado

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FT. MCCOY, WISCONSIN

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October 1981

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EXECUTIVE SUMMARY
OF
ENERGY ENGINEERING ANALYSIS PROGRAM
FOR
FT. MCCOY, WISCONSIN

0.1 GENERAL

0.1.1 Authority For Study

This planning study was performed and this report was prepared under Contract No. DACA 45-80-C-0028 issued by the Omaha District, Corps of Engineers, to Energy Management Consultants, Inc. of Denver, Colorado, on 13 May 1980.

0.1.2 Summary Of Scope Of Work

The Scope of Work for the basic contract is divided into three Increments; A, B and C. Increment A projects are those energy conservation projects related to the modification or retrofit of existing buildings. These projects may include building envelope retrofits, such as storm windows, vestibules and insulation as well as retrofits of heating, ventilating and air conditioning systems. Increment B projects involve utilities and energy distribution systems, modifications to existing energy plants, and an evaluation of the technical and economic feasibility of an Energy Monitoring and Control System (EMCS). Increment C projects relevant to this contract involve a preliminary assessment of the technical and economic feasibility of expanding the use of biomass fuel at Ft. McCoy. The results of the preliminary biomass analysis are summarized in this report. The results of the detailed analysis will be presented in a separate report.

The work to be accomplished for each increment is divided into three phases. They are:

- Phase I - Data gathering and field trips
- Phase II - Analysis of data, identification of projects, evaluation of technical and economic feasibility
- Phase III - Preparation of reports and project documentation

This Report covers work through all three phases of Increments A, B, and C.

Increments F and G have been added as modifications to the basic contract, the results of which will be presented in a separate report at a later date.

0.1.3 Report Volumes

The Final Report is divided into the following four parts:

- Executive Summary
- Volume I, Final Report
- Volume II, Appendices to Final Report
- Volume III, Formal Programming Documents

0.2 FACILITY DESCRIPTION

0.2.1 General

The 59,779 acre site on which Ft. McCoy is located was originally developed as a military reservation and artillery range used by regular Army troops in the early 1900's. The status of the installation has changed over the years with national defense needs and changes in policies. Activity was escalated during World War II and the Korean conflict, with the base reverting to an inactive status at other times. The post was designated Ft. McCoy in 1974, reflecting its status as a permanent military installation.

0.2.2 Mission

Ft. McCoy is both a regional support center and a maneuver training base. A summary of the mission areas is as follows:

- Plan, coordinate, and furnish administrative, logistic, maintenance and training support, as directed by Forces Command (FORSCOM), for operation at Ft. McCoy, in support of U.S. Army Reserve, Army National Guard, and other Reserve component units and activities utilizing Ft. McCoy for Annual Training (AT) and Multiple Unit Training Assembly (MUTA). Provide equivalent support to elements of the Active Army utilizing Ft. McCoy for field training.

- Provide related support to Reserve Component units during their Inactive Duty Training (IDT) period at home stations, and to Active Army Elements within the Ft. McCoy area of responsibility.

- Manage, maintain, and provide security and protection of personnel, real property and contents, grounds, roadways, and utility systems within the Ft. McCoy area of responsibility.

0.2.3 Climatological Data

There are wide and frequent variations in temperatures at Ft. McCoy The winters are cold and humid with frequent snowfalls. The summers are warm with moderate humidities.

0.2.4 Building Operating and Utilization Characteristics

Since Ft. McCoy is used primarily as a training center, the occupancy of most of the facilities fluctuates with the time of the year. During FY 1979 approximately 120 buildings were used 12 months of the year. The number of occupants in these 12-month buildings is relatively constant, with approximately 25% increase during the summer months, when most of the training activity occurs. Normal building occupancy for civilian employees is 7:30 AM to 4:00 PM, five days per week, with one half hour off for lunch.

Buildings used for Annual Training (AT) are generally occupied for several two week periods during the year, while buildings used for Multiple Unit Training Assembly (MUTA) are typically occupied on weekends only. Currently the Annual Training takes place from April through August, although use of Ft. McCoy for AT during the winter months is under consideration. MUTA training currently is conducted throughout the year, but most of it is during the summer.

Some planning for improving building utilization has been implemented at Ft. McCoy. For example, blocks 26, 27 and 28 are currently used for winter MUTA training as much as possible. This has permitted some upgrading of these buildings to make them more energy-efficient.

0.2.5 Energy Sources at Ft. McCoy

0.2.5.1 Electricity

Northern States Power Company (NSPCO) supplies power to Ft. McCoy via a 69 kilovolt (KV) transmission line. The electric rate schedule which applies to Ft. McCoy is a "ratchet-type" schedule, with charges based on various levels of demand and energy with on-peak and off-peak rates. A penalty for a power factor less than 0.90 is applied.

0.2.5.2 Fuel Oil

During FY 1979 approximately 13 percent of the total fossil fuel energy used was No. 2 fuel oil. The current cost of No. 2 fuel oil is $0.85 per gallon.

0.2.5 3 Liquid Petroleum Gas

Liquid petroleum gas (LPG) is used for space heating, cooking, and heating domestic water in numerous buildings throughout Ft. McCoy. During FY 79 approximately 32 percent of the total fossil fuel energy used at Ft. McCoy was LPG. The current price of LPG is approximately $0.65 per gallon.

0.2.5.4 Coal

Coal is used extensively at Ft. McCoy. Approximately 55 percent of the total fossil fuel energy used in FY 79 was supplied by coal. Coal is currently purchased at a cost of $54.24 per ton.

0.2.5.5 Wood

During FY 79, wood pellets were used to fire various boilers and furnaces on an experimental basis. Since then its use has been expanded to nine buildings at Ft. McCoy. Wood in pellet form is currently purchased at a cost of $69 per ton.

0.2.5.6 Summary of Fossil Fuel and Electrical Energy Use

Fossil fuel energy consumption at Ft. McCoy, excluding fuels used for transportion, consist of LPG, No. 2 fuel oil, coal and wood. Natural gas was supplied to Ft. McCoy at one time, but delivery has since been curtailed. Wood was not used during FY 1979 except on an experimental basis. Table ES.1 gives the breakdown of fossil fuel energy use from FY 75 through FY 79.

TABLE ES.1

PERCENT OF FOSSIL FUEL USE AT FT. McCOY

Energy Type	FY 75	FY 76	FY 77	FY 78	FY 79
LPG	39.0	43.0	46.0	33.0	31.7
Coal	43.0	38.0	29.5	50.5	54.8
No. 2 Fuel Oil	18.0	19.0	24.5	16.5	13.5

Ft McCoy has decreased its use of LPG and No. 2 fuel oil during 1978 and 1979 and increased its use of coal, in line with the long range goals of the Department of Defense (DOD).

The data presented in Table ES.2 shows an increase in the electrical percentage of total energy at Ft. McCoy.

TABLE ES.2

PERCENT (%) OF TOTAL SOURCE ENERGY* CONSUMPTION

	FY 75	FY 76	FY 77	FY 78	FY 79
ELECTRICITY	29.2	31.0	34.3	34.1	34.0
FOSSIL FUEL	70.8	69.0	65.7	65.9	66.0

* 1 KWH = 11,600 BTU

0.2.5.7 Energy Use vs Weather

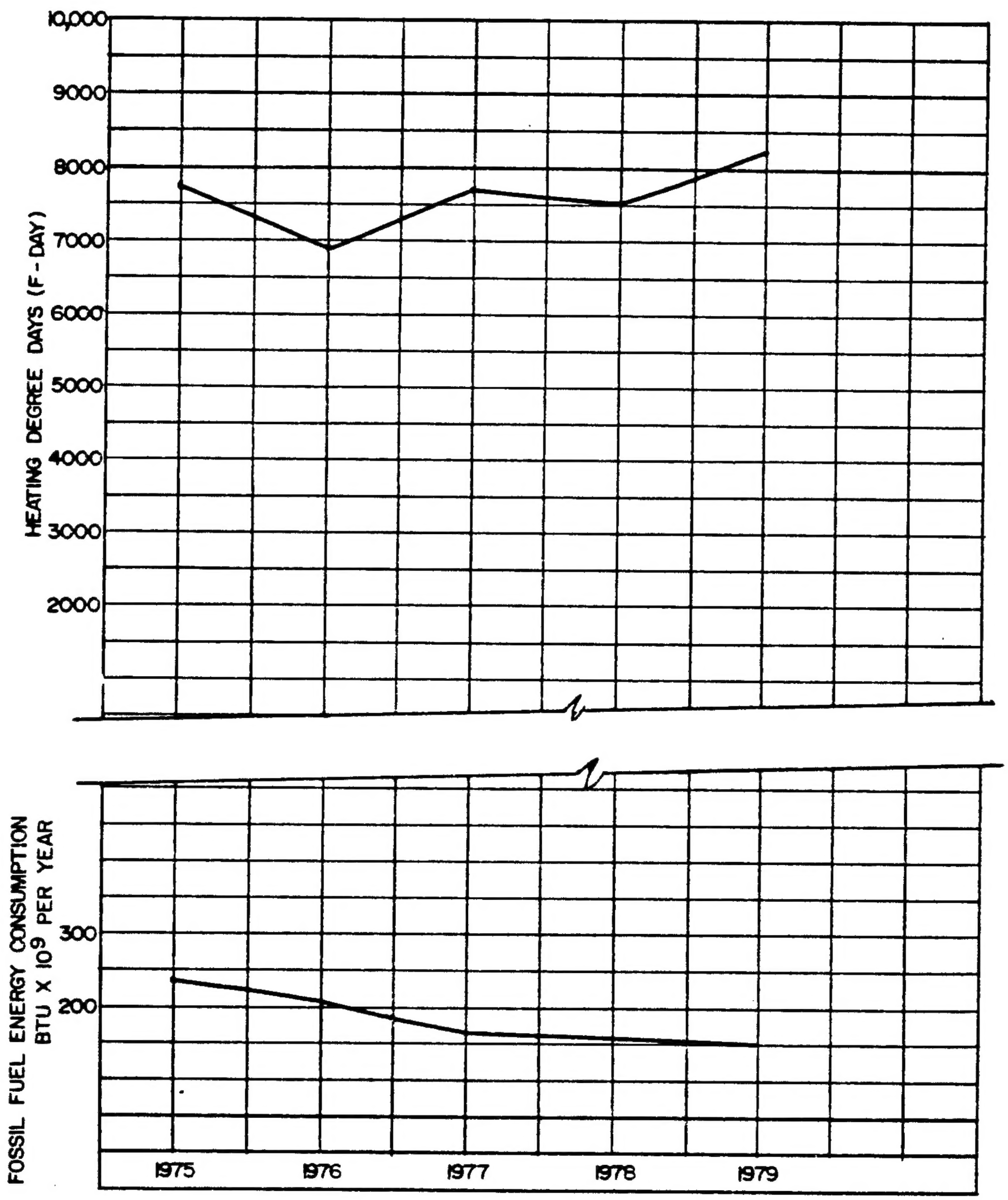
Figure ES.1 on the following page illustrates energy use and weather trends from FY 1975 through FY 1979. No direct correlation between weather and energy use was apparent, probably because energy conservation over the past several years has changed usage.

FIGURE ES.1

FOSSIL FUEL ENERGY CONSUMPTION

COMPARED WITH HEATING REQUIREMENTS

FT. McCOY



0.2.6 Energy Used by Utility Systems

0.2.6.1 Potable Water System

The water treatment and supply system uses energy primarily for pumping. Water from eleven deep wells located in the cantonment area is pumped into a low level reservoir where booster pumps elevate the water to a high level reservoir, which pressurizes the system. In FY 1979 approximately 104,000 KWH were used to pump water from the eleven wells into the low level reservoir, and 131,900 kwh more were used to pump the water to the high level reservoir.

0.2.6.2 Sewage Treatment

Sewage treatment uses energy in the digestion process, in heating the main building at the sewage treatment center, and in pumping. A gas generator which captures and stores the methane gas generated by the solid wastes was recently installed. The generator produces adequate gas to use in the digestion process over the five or six summer months when troop levels are highest. Approximately 67,700 KWH of electricity were used for pumping, driving the aerating equipment, and for miscellaneous uses at the sewage treatment facility during 1979. The thermal energy (provided by oil and gas) used at the sewage treatment plant during FY 1979 was approximately 2440 million BTU.

0.2.6.3 Central Plant and Steam Distribution

A central steam plant serves the hospital area (block 10) of Ft. McCoy. Three, 500 horsepower, coal-fired boilers and a 15 million BTU per hour oil-fired boiler are used to supply steam to this area. The coal fired boilers are original equipment while the oil fired boiler is a relatively recent addition. During normal peace-time training periods the hospital area is used only during the summer months. During the summer of 1980 the coal-fired boilers in the hospital area were fired with wood pellets to bring the boilers into compliance with air quality standards.

The steam distribution system serving block 10 (hospital area) is an overhead network of supply steam and return condensate piping. Distribution of the steam can be controlled with isolation valves so that the system serves only those parts of block 10 which are being used at a given time. The losses from the steam piping, 658 million BTU per year, are approximately equal to the actual process loads in the buildings.

0.2.6.4 Electrical Distribution and Exterior Lighting, Street and Parking

Line losses through the distribution system were estimated by metering to be approximately 222,000 KWH/YR. This is 3.2 percent of the total annual kilowatt- hours (KWH) used.

The exterior lighting at Ft. McCoy is comprised of mercury vapor, high-pressure sodium, and incandescent lights. The lighting is controlled by a photocell signal, but can be manually controlled to override the photocell, thereby turning off lighting when areas of the post are not in use. It is estimated that 266,000 KWH per year are consumed by the exterior lighting system, or approximately 3.9 percent of the total electrical energy consumed at Ft. McCoy during FY 1979.

0.2.6.5 LPG Distribution

Two areas of Ft. McCoy are served by a distribution network of gas piping: Blocks 11 through 14 and a small area of block 17. The remaining buildings served by LPG have individual tanks at each building or share a tank.

0.2.7 Space Conditioning and Process Energy

Estimates of the energy used for space heating, cooling, process and domestic water at Ft. McCoy are as follows for FY 1979:

Energy Use	BTU x 10^9/YR
Space heating	105.5
Space Cooling	4.3
Process and Domestic Water	52.9

In addition, energy consumed in space heating, process purposes and losses, in the hospital area during FY 1979 (block 10) is as follows:

SUMMARY OF BLOCK 10 (HOSPITAL AREA) ENERGY USAGE

Description of Energy Load	Estimated Energy Used (BTU x 10^6/YR)	Percent of Energy Used (%)
Building Process and Heating Loads	688	15
Distribution Losses	658	15
Plant Conversion Losses	3140	70

0.2.8 Composite Results of Energy Usage at Ft. McCoy

Energy usage at Ft. McCoy is summarized in Table ES.3 on the following page. This data is displayed graphically in Figure ES.2 on page ES-11. It is apparent from Figure ES.2 that space heating in the buildings occupied 12 months of the year is the predominant fossil fuel energy user, with process and domestic water heating (primarily in the barracks) the second largest fossil fuel energy user.

Because the utilization of buildings at Ft. McCoy varies considerably depending upon training requirements, designation of individual building types which are truly typical of all others is difficult. The estimated energy use of representative type buildings, however, is summarized below:

Building Number	Building Type	Fossil Fuel (mBtu/yr)	Electricity (kWh/yr)
202	EM Barracks	33.7	156
402	EM Barracks	137.6	867
502	EM Barracks	168.5	1276
1105	EM Barracks	3.7	2435
451	BOQ Male	68.9	4626
1313	BOQ Male	26.5	8766
227	ENL Mess	19.4	4879
406	ENL Mess	47.2	5503
100	HQ Admin	1087.4	36,467
433	Admin	0	925
232	Admin	0	282
645	Motor Repair Shop	0	2182
826	Class Room	0	5795
1012	BOQ Female	96.8	4626
1023	Hospital	118.8	1159
1153	Warehouse	0	168
2123	Warehouse	739.1	13,539
2017	Theater	0	487

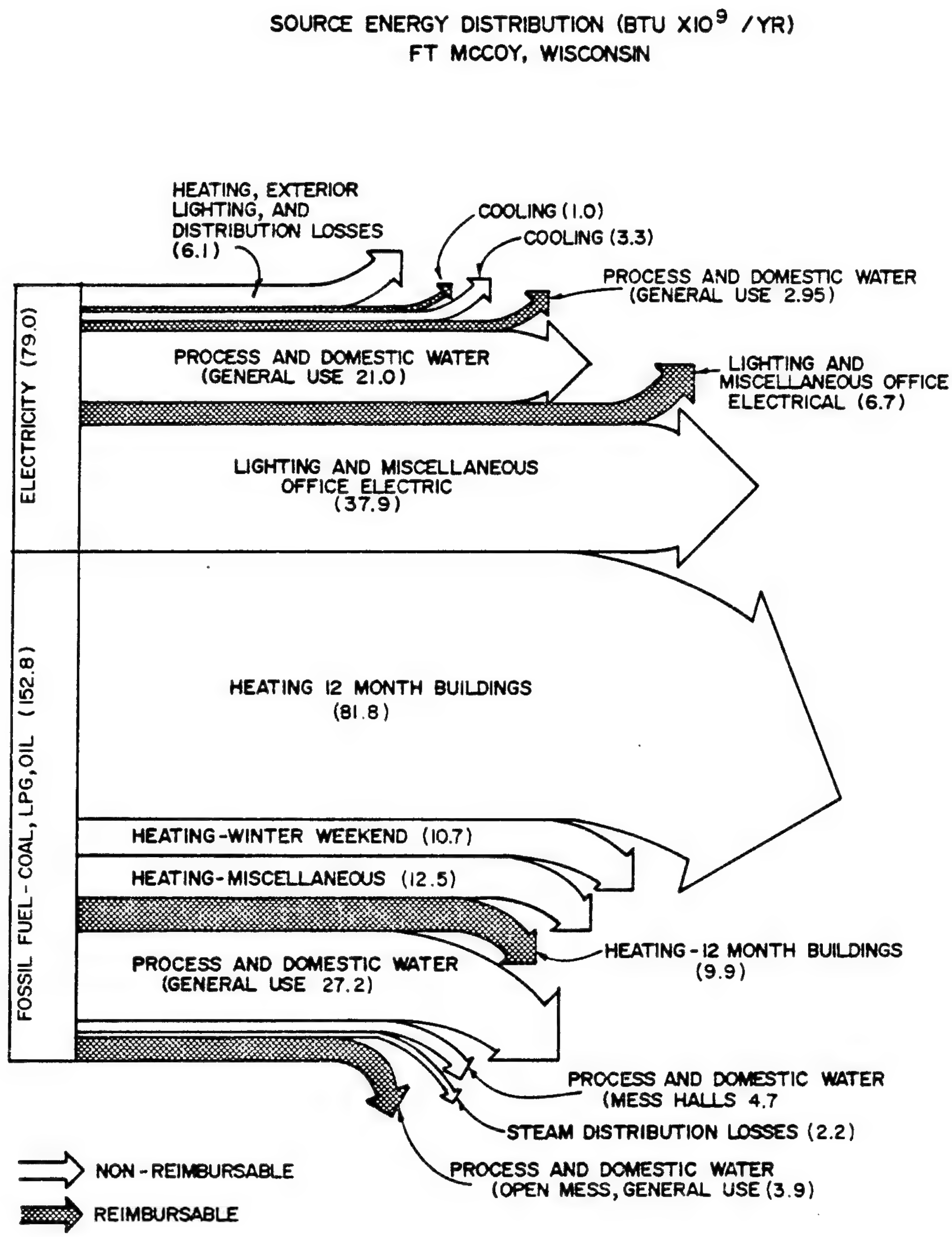
TABLE ES.3

SUMMARY OF RESULTS OF ENERGY ANALYSIS - FY1979

ENERGY USE	FUEL TYPE ($Btu \times 10^6/yr$)			
HEATING	COAL(tons)*	GAS(kgal)*	OIL(kgal)*	ELECTRICITY(mWh)*
Reimbursable				
12 month buildings	3,050 (124)	2,620 (27.4)	4,260 (31)	0
Subtotal-Reimbursable	3,050 (124)	2,620 (27.4)	4,260 (31)	0
Non-Reimbursable				
12 month buildings	46,000 (1870)	29,000 (304)	6,820 (49)	482 (42)
Winter Weekend Occupied	10,200 (415)	470 (5)	0	0
Miscellaneous	12,400 (504)	30 (.3)	0	0
Subtotal-Non-Reimbursable	68,600 (2789)	29,500 (309)	6,820 (49)	482 (42)
PROCESS AND DOMESTIC WATER				
Reimbursable				
General Use	0	615 (6.4)	2,690 (19)	2,950 (254)
Mess Halls	0	565 (6.0)	0	0
Subtotal - Reimbursable	0	1,180 (12.4)	2,690 (19)	2,950 (254)
Non-Reimbursable				
General Use	12,000 (483)	10,530 (110)	4,680 (34)	21,000 (1810)
Mess Halls	0	4,670 (49)	0	0
Subtotal-Non-Reimbursable	12,000 (488)	15,200 (159)	4,680 (34)	21,000 (1810)
MISCELLANEOUS ENERGY USE				
Reimbursable				
Lighting and Misc. Electric	0	0	0	6,650 (573)
Cooling	0	0	0	1,030 (89)
Subtotal-Reimbursable	0	0	0	7,680 (667)
Non-Reimbursable				
Lighting and Misc. Electric	0	0	0	37,900 (3267)
Cooling	0	0	0	3,310 (285)
Exterior Lighting	0	0	0	3,090 (266)
Electrical Distribution Loss	0	0	0	2,550 (220)
Steam Distribution Loss	0	0	2,190 (16)	0 (0)
Subtotal-Miscellaneous	0	0	2,190 (16)	46,850 (4038)
ESTIMATED TOTALS				
Reimbursable	3,050 (124)	3,800 (40)	6,950 (50)	10,630 (916)
Non-Reimbursable	80,600 (3276)	44,700 (468)	13,690 (99)	68,332 (5891)
TOTAL	83,650 (3400)	48,500 (508)	20,640 (149)	78,962 (6807)
Rounded To	83,700	48,500	20,600	78,900
Actual Totals	83,700 (3410)	48,500 (508)	20,600 (149)	78,900 (6806)
(FY1979 Utility Bills)				

* Numbers in parentheses are equivalent quantities of energy measured in tons, kgal, and mWh for coal, gas and oil, and electricity respectively.

FIGURE ES-2


SOURCE ENERGY DISTRIBUTION (BTU X10^9 /YR)
FT McCOY, WISCONSIN
HEATING, EXTERIOR LIGHTING, AND DISTRIBUTION LOSSES (6.1)
COOLING (1.0)
COOLING (3.3)
PROCESS AND DOMESTIC WATER (GENERAL USE 2.95)
ELECTRICITY (79.0)
PROCESS AND DOMESTIC WATER (GENERAL USE 21.0)
LIGHTING AND MISCELLANEOUS OFFICE ELECTRICAL (6.7)
LIGHTING AND MISCELLANEOUS OFFICE ELECTRIC (37.9)
FOSSIL FUEL - COAL, LPG, OIL (152.8)
HEATING 12 MONTH BUILDINGS (81.8)
HEATING-WINTER WEEKEND (10.7)
HEATING-MISCELLANEOUS (12.5)
HEATING - 12 MONTH BUILDINGS (9.9)
PROCESS AND DOMESTIC WATER (GENERAL USE 27.2)
PROCESS AND DOMESTIC WATER (MESS HALLS 4.7
STEAM DISTRIBUTION LOSSES (2.2)
PROCESS AND DOMESTIC WATER (OPEN MESS, GENERAL USE (3.9)
NON - REIMBURSABLE
REIMBURSABLE

Lighting and miscellaneous office equipment is the largest user of electrical energy, with process and domestic water the second largest user. These four categories total approximately 167 x 10^9 BTU per year, or 72 percent of the total source energy used at Ft. McCoy. Consequently, most of the energy conservation opportunities (ECOs) occur in these categories. The ECOs investigated are described in the following Section (0.3) of the Executive Summary.

0.3 ENERGY CONSERVATION OPPORTUNITIES

0.3.1 General

Energy conservation has been important at Ft. McCoy for several years. Conservation efforts are reflected in utility bills indicating a significant reduction in energy consumption. The ECOs investigated under this study are part of an effort to extend the energy conservation work already done at Ft. McCoy and to develop a plan of implementation which will allow the Army goals of planned energy reduction to be achieved.

ECOs were analyzed on an individual basis to begin with, and energy savings are in comparison to facilities as they are now.

The effects of ECO interrelationships were accounted for when the ECOs were grouped into projects, described in Section 0.5 of the Executive Summary.

0.3.2 Description of ECOs Investigated

ECOs were evaluated for normal, peacetime use of the facilities at Ft. McCoy, for which 1979 was taken to be a representative year. ECOs have been categorized as follows:

- Building Envelope Modifications
- HVAC Equipment Modifications
- Process System and Building Lighting Systems Modifications
- Utilities and Energy Distribution Systems Improvements

Buildings applicable to a specific ECO were grouped in categories. The buildings in each category are listed in Appendix F. Because of the possibilities for different combinations of similar building traits, a building may appear in more than one category. Thus the energy consumption figures for each grouping are misleading when considered in total. A summary of the different categories follows:

Group A - Buildings occupied 12 months a year and approximately 8 hours per day. These buildings consume approximately 51,654 mBtu (fossil fuel) and 1,125,473 kWh of electricity per year.

Group B - Buildings occupied 12 months a year, 24 hours per day. These buildings consume approximately 21,596 mBtu (fossil fuel) and 861,862 kWh of electricity per year.

Group C - Buildings occupied 12 months a year with varying occupancy per day. These buildings consume approximately 7,968 mBtu (fossil fuel) and 143,567 kWh of electricity per year.

Group D - Buildings used 12 months a year and heated to a temperature adequate for freeze protection (40° F). These buildings consume approximately 1,010 mBtu (fossil fuel) and 4,908 kWh of electricity per year.

Group E - Buildings used 12 months a year having coal fired heating plants. These buildings consume approximately 44,771 mBtu (fossil fuel) and 855,727 kWh of electricity per year.

Group F - Buildings not having double glazed glass and used 12 months a year. These buildings consume approximately 27,772 mBtu (fossil fuel) and 470,029 kWh of electricity per year.

Group G - Buildings used 12 months a year which require additional insulation. These buildings consume approximately 63,431 mBtu (fossil fuel) and 1,864,757 kWh of electricity per year.

Group H - Buildings used 12 months a year having truck doors. These buildings consume approximately 23,931 mBtu (fossil fuel) and 398,651 kWh of electricity per year.

Group I - Buildings used 12 months a year having gas fired boilers. These buildings consume approximately 6566 mBtu (fossil fuel) and 295,273 kWh of electricity per year.

Group J - Enlisted men and womens barracks requiring showerhead flow restrictors. These buildings consume approximately 34,444 mBtu (fossil fuel) and 588,999 kWh of electricity per year.

Group K - Enlisted men and womens barracks in blocks 26, 27, and 28 used for winter MUTA training. These buildings consume approximately 7879 mBtu (fossil fuel) and 52,590 kWh of electricity per year.

Group L - Mess halls used 12 months of the year. These buildings consume approximately 2650 mBtu (fossil fuel) and 185,527 kWh of electricity per year.

Group M - Buildings used 23 months a year having boilers with capacities greater than 2 million Btu per hour. These buildings consume approximately 5126 mBtu (fossil fuel) and 247,133 of electricity per year.

Group N - Buildings used 12 months a year having gas heating plants. These buildings consume approximately 22,251 mBtu (fossil fuel) and 589,926 kWh of electricity per year.

Group O - Buildings used 12 months a year having high bay areas. These buildings consume approximately 11,465 mBtu (fossil fuel) and 102,262 kWh of electricity per year.

Group P - Buildings used 12 months a year not having storm doors. These buildings consume approximately 44,183 mBtu (fossil fuel) and 1,393,934 kWh of electricity per year.

Group Q - Buildings used 12 months a year which need a vestibule and door weatherstipping. These buildings consume approximately 45,075 mBtu (fossil fuel) and 1,171,510 kWh of electricity per year.

Group R - Bachelor Officers Quarters (BOQs) which are candidates for solar domestic water preheat. These buildings consume approximately 7532 mBtu (fossil fuel) and 171,301 kWh of electricity per year.

Group S - Buildings having 40 watt fluorescent tubes which can be relamped with 35 watt fluorescent tubes. These buildings consume approximately 45,263 mBtu (fossil fuel) and 1,338,838 kWh of electricity per year.

Group T - Buildings in block 10 which would require local domestic water and process heating units if use of the central boiler was discontinued. These buildings consume approximately 2262 mBtu (fossil fuel) and 62,365 kWh of electricity per year.

Group U - Buildings having modular gas furnaces. These buildings consume approximately 19,234 mBtu (fossil fuel) and 497,887 kWh of electricity per year.

Group V - Active Mess Halls. These buildings consume approximately 14,715 mBtu (fossil fuel) and 1,196,293 kWh of electricity per year.

Group W - Buildings used 12 months per year which can use local loop controls for automated day and night setback. These buildings consume approximately 24,754 mBtu (fossil fuel) and 628,970 kWh of electricity per year.

Group X - Buildings needing improved local-loop stoker control. These buildings consume approximately 6502 mBtu (fossil fuel) and 116,849 kWh of electricity per year.

Group Y - Buildings with uninsulated steam and condensate return piping. These buildings consume approximately 37,670 mBtu (fossil fuel) and 1,469,071 kWh of electricity per year.

Group Z - BOQs and barracks with gas domestic water heaters. These buildings consume approximately 12,611 mBtu (fossil fuel) and 308,502 kWh of electricity per year.

0.3.2.1 Building Envelope Modifications

The following ECOs are related to building envelope modifications.

1) Caulk Windows

Description: Infiltration will be reduced by caulking all cracks around windows.

2) Double Glaze Windows

Description: Consider installing outside, aluminum frame, operable storm windows on administration type buildings and fixed storm windows on buildings which do not currently have operable windows. Energy savings are achieved through the decrease in both thermal conductance of the windows and infiltration through perimeter cracks.

3) Triple Glaze Windows

Description: Consider installing a third pane on the inside of windows, in addition to aluminum frame outside storm windows, resulting in a further decrease in conductance and in infiltration.

4) Weatherstrip Doors and Add Vestibules

Description: Consider installing a vestibule on the heaviest used door of each building and weatherstripping all doors (including truck doors) of the building. Weatherstripping reduces the continual infiltration around the perimeter cracks. The vestibule does the same and, further reduces the additional infiltration occurring when the door is opened for traffic. Maximum energy savings are achieved by arranging for most traffic to flow through the vestibule. See Figure ES.3 on the following page for the vestibule types.

5) Storm Doors Only

Description: Consider installing storm doors on all doors of each building under consideration, thereby reducing infiltration.

6) Window Insulation

Description: Consider installing opaque insulating panels over existing north facing windows. The seal obtained with such insulation provides for a significant reduction in infiltration as well as window thermal conductance.

7) Add Insulation Where Needed

Description: Consider insulating walls, roofs, and floors of those buildings or parts of buildings occupied 12 months per year.

8) Truck Door Insulation

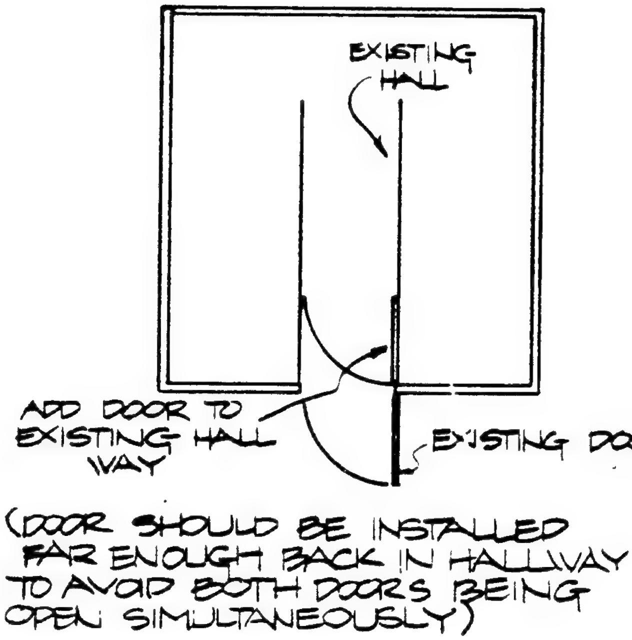
Description: Semi-rigid insulating panels can be installed on the inside of large sliding or overhead truck doors, to reduce thermal conduction losses.

0.3.2.2 HVAC Equipment Modifications

The following ECOs are related to HVAC equipment modifications.

FIGURE ES.3

VESTIBULE TYPES



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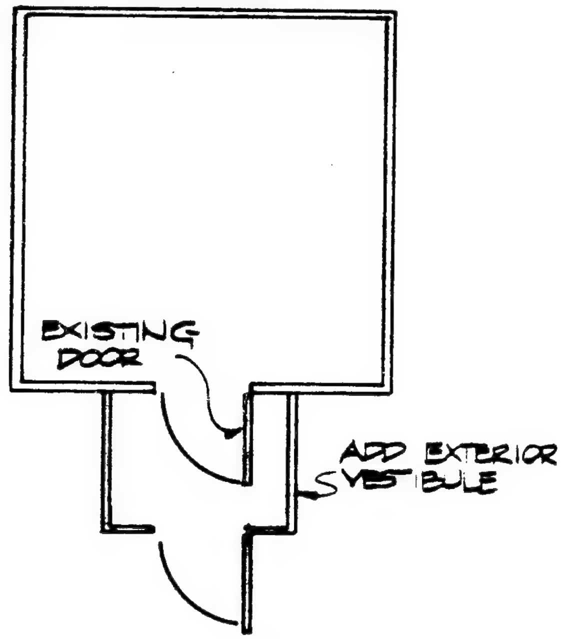

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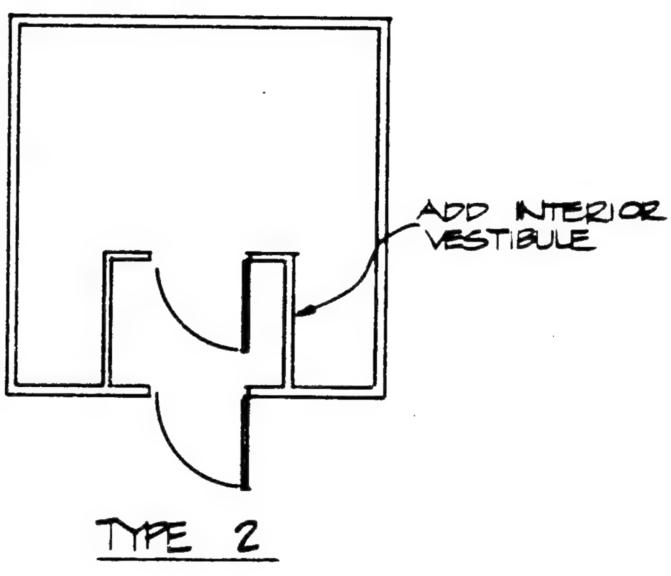


TYPE 2

9) Resize Heating Plants

Description: Many of the heating plants at Ft. McCoy are substantially oversized. This is due to energy conservation measures which have been implemented over the years and initial plant oversizing, which was often common engineering practice in past years.

Because of oversize, the heating plants run in a cycling mode more than is necessary, thus wasting energy.

10) Flue Gas Dampers

Description: Electronic ignition with flue dampers should be considered for all gas-fired boilers. Losses from the boilers when in a stand-by condition will be reduced.

11) Stack Economizer

Description: Stack economizers should be considered for all steam boilers of appreciable size. The recovered heat would be used to preheat the boiler feedwater and thereby increase the boiler efficiency.

12) Ventilation Air Damper Seals

Description: This ECO involves the installation of seals on the outside air dampers on all barracks used 12 months a year as well as in barracks used in early spring or late fall. By reducing the ventilation air to 5 CFM per occupant, less energy is required to heat ventilated air to room temperatures.

13) High Efficiency Gas Furnaces and Domestic Water Heaters

Description: Typical gas, forced-air, furnaces have an average seasonal efficiency of approximately 50 to 60 percent. New, condensing, forced air furnaces (which take advantage of the latent heat associated with the flue gas) are substantially more efficient. Consider replacing the existing gas furnaces. Also, in those buildings used 12 months a year having large domestic water heating requirements, consider replacing the conventional water heaters with improved efficiency, flue-gas condensing, water heaters.

14) Ceiling Fans

Description: Ceiling fans can be installed in high bay areas to reduce stratification of heated air, which raises the average room temperature.

15) Automated Day and Night Setback Control

Description: Consider installing programmable thermostats to reduce space temperatures automatically during unoccupied periods. They can be used for buildings with forced air furnaces, unit heater systems, and steam radiation. (Only for buildings not recommended for inclusion with EMCS.)

16) Improved Stoker Control - Coal Fired Furnace and Boiler

The combustion efficiency of coal fired forced air furnace systems and steam boilers can be increased by improving the present method of stoker control. Increasing the thermostat setpoint at morning occupancy currently results in prolonged stoker run time, which overstokes the furnace and decreases combustion efficiency.

Installation of a time-delayed relay circuit would prevent overstoking (only for buildings not recommended for inclusion with the EMCS.)

17) Outside Air Reset Control - Hot Water Boiler

This ECO would provide a temperature controller which resets the hot water supply temperature as a function of outdoor temperature.

0.3.2.3 Process System and Building Lighting System Modification

The following ECOs are related to process system or lighting system modifications:

18) Hot Water and Steam Pipe Insulation

Description: In general, the domestic water piping in the barracks mechanical rooms and steam and condensate return piping in various buildings throughout the post are not insulated. Consider insulating the piping.

19) Showerhead Flow Restrictors

Description: Flow restrictors can be added in showerheads to limit the water flow to 2.5 GPM or less, saving energy used for heating the water.

20) Range Side Curtains

Description: Side curtains installed on the mess hall ranges will permit a reduction in exhaust air, while still maintaining approximately the same face velocity. Energy savings results from the reduced volume of warmed make-up air. See Figure ES.4 on the following page.

21) Short Circuit Exhaust Hoods

Description: A portion of the make-up air can be introduced directly into the kitchen exhaust hood, thereby saving heating energy which would be used to temper this air. See Figure ES.5 on page ES-19.

22) Replace 40 W Fluorescents with 35 W Fluorescents

Description: Four foot, 40 watt, rapid start, fluorescent tubes can be replaced with 4 foot, 35 watt, rapid start, tubes. Some ballasts, however, will have a shorter life when used with the lower wattage tubes, and therefore should not be used with them unless the ballast is near the end of its useful life.

The average useful life of a ballast is approximately 12 years, and if replacement of the ballast is necessary, a ballast compatible with the lower watt tubes should be considered.

23) Solar Preheat of Domestic Hot Water

Description: Domestic and process water can be preheated using conventional flat plate solar collectors. Up to 80 percent of the domestic load can often be economically achievable with a solar preheat system.

0.3.2.4 Utilities and Energy Distribution Systems Improvements

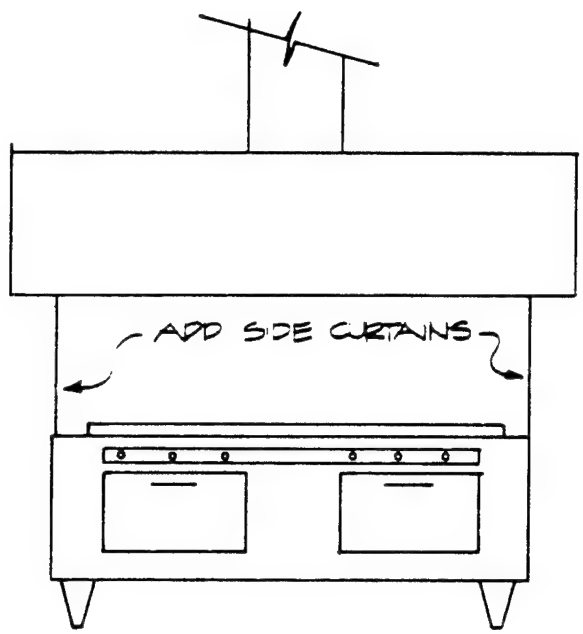
The following ECOs are related to the improvement of utilities or energy distribution systems at Ft. McCoy.

24) During periods of low building utilization in the hospital area (Block 10) discontinue use of the central plant steam boiler. Three options to this ECO were analyzed.

Description: The steam boiler serving block 10 during normal peacetime periods is lightly loaded. A major portion of the boiler load results from the distribution losses of the system. During those infrequent periods when heating is required, the existing central boiler plant would still be used.

FIGURE ES.4

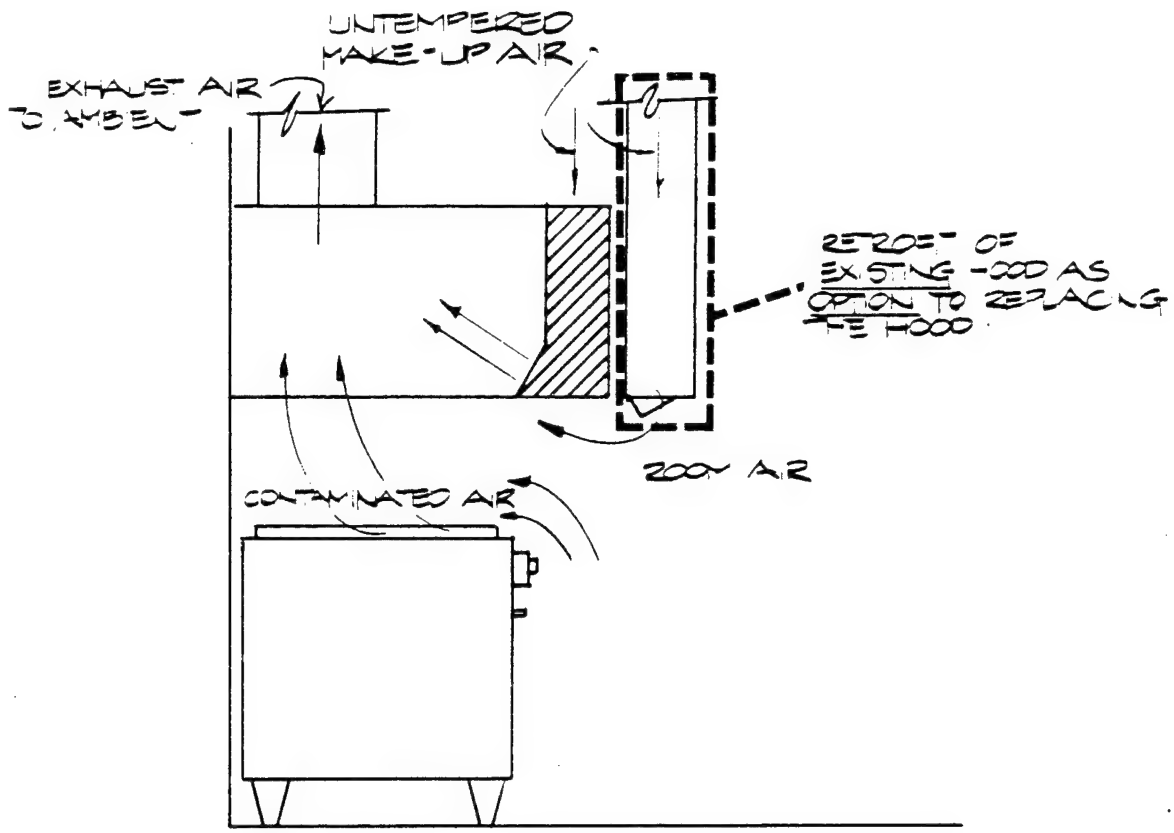
SIDE CURTAINS ON MESS
HALL RANGES



SIDE CURTAINS ON RANGES TO REDUCE
REQUIRED EXHAUST AIR VOLUME

FIGURE ES.5

SHORT CIRCUIT EXHAUST HOOD



SHORT CIRCUIT EXHAUST HOOD DESIGN

The three options considered were as follows:

Option A - Consider installing a small, coal-fired steam boiler near the buildings in Block 10 normally used during the training season (see Figure ES.6 on the following page). The existing steam distribution lines, steam sterilizers and steam hot water converters would be used. Energy savings will result from reduced line losses and an improved boiler efficiency.

Option B - Consider installing condensing-type, LPG-fired, hot water boilers in those buildings normally used during the training season (see Figure ES.7 on page ES-22.) Line losses from the main steam distribution system will be eliminated and the efficiency of the water heating process improved. Maximum efficiency in energy use results from this option.

Option C - Consider installing conventional, integral storage, LPG-fired, domestic water heaters in those buildings normally used during the training season. Advantages are similar to those from Option B but the costs are lower.

25) Exterior Lighting

Description: Consider replacing the existing mercury vapor street and parking-lot lights with high-pressure sodium or other more efficient lighting.

0.3.2.5 Unique ECOs

There are several ECOs which apply only to specific buildings at Ft. McCoy.

26) Humidistat in Swimming Pool Area

Description: A constant volume of outside air is presently supplied to the swimming pool room to control humidity levels and thereby eliminate condensation on the walls and ceilings.

The humidity level in the space can be controlled as a function of outside air temperature, by controlling the volume of outside air to the space. Heating energy will be saved.

27) Swimming Pool Cover

Description: Typically, the largest part of a swimming pool heating load goes to evaporating the pool water. If during unoccupied periods the pool is covered, this evaporation load can be

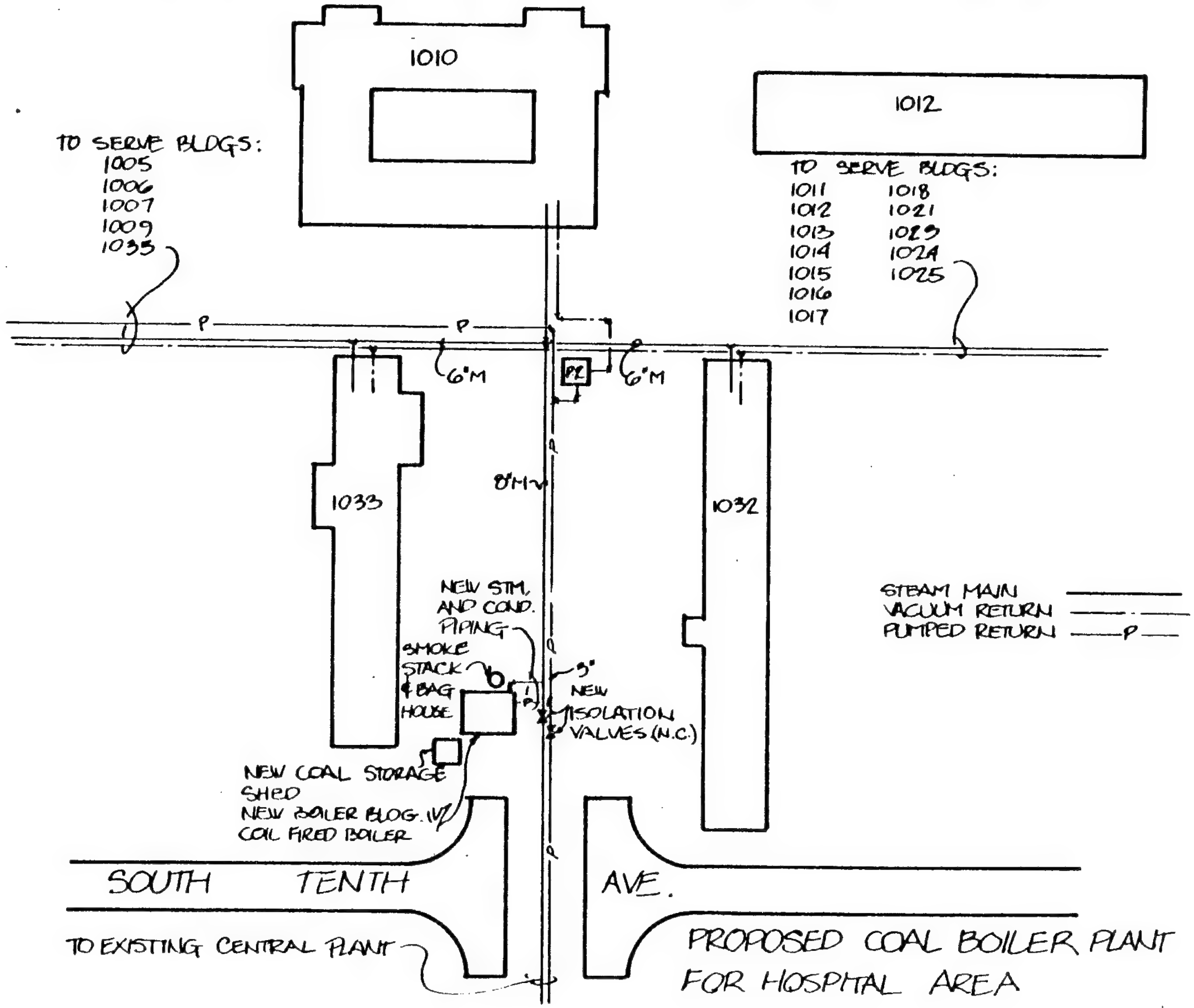
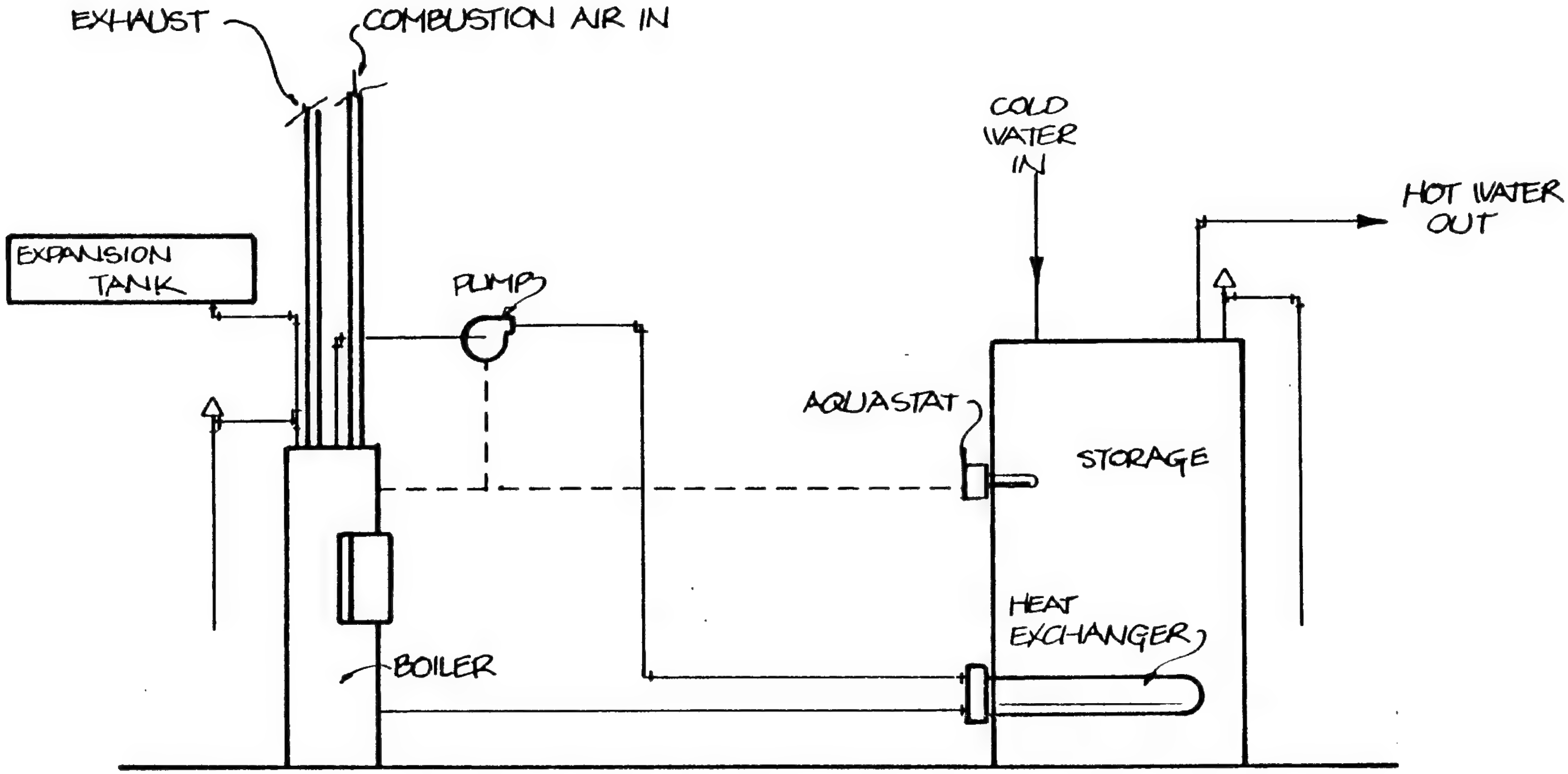

1010
1012
TO SERVE BLDGS:
1005
1006
1007
1009
1033
TO SERVE BLDGS:
1011
1012
1013
1014
1015
1016
1017
1018
1021
1023
1024
1025
P
P
6"M
6"M
8"M
1033
1032
STEAM MAIN
VACUUM RETURN
PUMPED RETURN
NEW STM. AND COND. PIPING
SMOKE STACK & BAG HOUSE
3"
NEW ISOLATION VALVES (N.C.)
NEW COAL STORAGE SHED
NEW BOILER BLDG. W/ COIL FIRED BOILER
SOUTH TENTH AVE.
TO EXISTING CENTRAL PLANT
PROPOSED COAL BOILER PLANT FOR HOSPITAL AREA

FIGURE ES.6

FIGURE ES.7



CONDENSING TYPE BOILER FOR DOMESTIC HOT WATER.

eliminated. Make-up air used for humidity control can also be eliminated during these unoccupied periods, thereby saving heating energy.

28) Replace Lights in High Bay Areas with High-Pressure Sodium (HPS) Type

Description: Incandescent and mercury vapor type lights are frequently used in high bay areas. Lighting levels can be maintained with substantially fewer fixtures if HPS lights are used. Demand and electrical energy savings will accrue.

29) Heat Recovery in Paint Room

Description: The paint room in building 3050 is used each workday for 12 months a year. The make-up air to the paint room can be heated with the exhaust air using an air to air heat exchanger. A portion of the energy used to heat the outside air will be saved.

30) Replace Electric Heat

Description: Electric heat in the paint storage room can be replaced with hot water unit heaters.

31) Eliminate Mechanical Refrigeration During Winter Months in Cold Storage Building

Description: Mechanical refrigeration is presently used during the winter months in the freezer room of Building 2114. The refrigeration equipment could be turned off when ambient temperatures are sufficiently cold to maintain the desired freezer temperature.

0.3.3 Summary of Results of Preliminary ECO Analysis

The ECOs described in Section 0.3.2 were assessed for technical and economic feasibility. Those ECOs meeting the ECIP economic criteria, revised by letter dated 27 January 1981, were grouped into projects. The revised minimum E/C ratio for 1983 is 14 while the maximum payback period criterion remained unchanged (must payback within the economic life of the ECO). The preliminary payback periods and E/C ratios of all of the ECOs are summarized in Table ES.4 found on pages ES-25 and ES-26.

ECOs numbered 9, 12, 20, 25, 26, 27 and 30 are to be implemented by Ft. McCoy facility engineering personnel. ECO number 10 (flue dampers in gas boilers) will not be implemented at the present time. This is the result of a Department of Army recommendation to facility engineering personnel which recommends against using flue dampers in LPG-fired boilers on a retrofit basis. Implementation of ECO number 22, "Replace 40 watt fluorescents with 35 watt fluorescents", will be deferred until Increment G since replacement of lighting tubes and ballasts is a normal maintenance function. If the replacement was done on a contract basis, with additional labor costs included, the ECO would no longer meet ECIP economic criteria. To be cost effective, ECO No. 25, "Exterior Lighting" would be implemented only in areas where the lighting is used year-round. All other ECOs meeting the ECIP economic criteria have been included in the project analysis, with the results presented in Section 0.5 of this Summary.

TABLE ES.4

SUMMARY OF RESULTS OF PRELIMINARY ANALYSIS

ECO NO.	ECO DESCRIPTION	SIMPLE PAYBACK (YRS)	E/C RATIO (kBtu/$)
1)	Caulk Windows	1.7	101
2)	Double Glaze Windows	7.7	26.7
3)	Triple Glaze Windows	10.7	18.8
4)	Weather Strip Doors and Add Vestibules	2.2	68.9
5)	Storm Doors	0.5	300
6)	Window Insulation	4.6	43.6
7)	Add Insulation	5.7	31.1
8)	Truck Door Insulation	1.9	109
9)	Resize Heating Plants	0.5	208
10)	Flue Gas Dampers	2.3	48.4
11)	Stack Economizer	16.5	13.7
12)	Ventilation Air Damper Seals	17.0	20.6
13)	Condensing Furnaces and Domestic Water Heaters	5	21.4
14)	Ceiling Fans	2.0	120
15)	Auto Day/Night Setback	4.7	32.5
16)	Improved Stoker Control	9.6	34.5
17)	Outside Air Reset Control	6.0	17.8
18)	Hot Water and Steam Pipe Insulation	7.9	21.8
19)	Showerhead Flow Restrictors	7.8	22.1
20)	Range Side Curtains	14.6	20.3
21)	Short Circuit Exhaust Hoods	37.7	7.6
22)	Replace 40 W Fluorescents with 35 W Fluorescents	6.2	28.3

TABLE ES.4 (Cont)

SUMMARY OF RESULTS OF PRELIMINARY ANALYSIS

ECO NO.	ECO DESCRIPTION	SIMPLE PAYBACK (YRS)	E/C RATIO (kBtu/$)
23)	Solar Preheat of Domestic Water	24.7	4.5
24)	Discontinue Use of Existing Block 10 Central Boiler		
	(a) Small Central Coal Fired Boiler	4.5	17
	(b) Condensing Type Boiler	4.7	24
	(c) Conventional Gas Water Heaters	3.2	36
25)	Exterior Lighting	9.2	19.3
26)	Humidistat in Swimming Pool Area	0.3	365
27)	Swimming Pool Cover	0.7	157
28)	Replace Lights in Gym Swimming Pool, and buildings 1463, 2320, and 3050 with High Pressure Sodium (HPS) Type	6.6	42.4
29)	Heat Recovery in Paint Room	10.9	10.4
30)	Replace Electric Heat	9.7	18.2
31)	Replace Mechanical Cooling in Cold Storage Building (Winter Only)	31.2	15.2

0.3.4 Energy Monitoring and Control System (EMCS) Options

Three alternate EMCS designs were considered for application at Ft. McCoy. Each has a different EMCS configuration, cost and potential energy savings. A summary follows:

0.3.4.1 Option No. 1

Option No. 1 uses only telephone lines for communication. This option includes all EMCS functions in all of the buildings studied which meet the ECIP economic criteria. The EMCS configuration for Option No. 1 consists of a Master Control Room (MCR), telephone communications links, field devices, and software. The MCR includes a Central Control Unit (CCU), printer, black and white Cathode Ray Tube (CRT), and all software required to perform the EMCS functions.

The total energy savings for Option No. 1 represents a first year source energy reduction of 3,510 x 10^6 BTUs. The energy savings for Option No. 1 are summarized in Table ES.5 below.

TABLE ES.5

ESTIMATED ENERGY SAVINGS OPTION NO. 1

	KW	KWH	10^6 BTU/YR	% of 1979 ENERGY USAGE
Electrical Energy Saved	48	14,800	-	0.2
Fossil Energy Saved	-	-	3340	2.4
Total Source Energy Saved	-	-	3510	1.6

Option No. 1 would reduce the first year (1983 dollars) energy expenditure by $21,000. After deducting for first year maintenance cost, the simple payback is 12.7 years and E/C is 21.5.

0.3.4.2 Option No. 2

Option No. 2 expands the system described above by adding radio communications to control additional functions.

Radio communication was considered for all EMCS functions utilizing on/off control which did not meet the simple payback or E/C criteria when using telephone lines for communication. The functions which met the simple payback and E/C criteria when controlled by radio controlled relays were included in Option No. 2.

The MCR configuration for Option No. 2 is the same except for the addition of a radio transmitter and radio receiver switches.

Radio communication is a satisfactory method of on/off control for simple systems, such as many of the heating and cooling systems at Ft. McCoy. Space temperature is controlled by cycling the heating or cooling systems according to a predetermined schedule by the central processing unit. The CPU will reset the cycling intervals based on the outdoor air temperature. The main disadvantage of this type of control is the lack of any feedback to the CPU from the controlled space.

The total energy savings for Option No. 2 represents a first year source energy reduction of 6320 x 10^6 BTUs. The energy savings for Option No. 2 are summarized in Table ES.6 below.

TABLE ES.6

ESTIMATED ENERGY SAVINGS OPTION NO. 2

	KW	KWH	10^6BTU/YR	% OF 1979 ENERGY USAGE
Electrical Energy Saved	136	30,700	-	0.45
Fossil Energy Saved	-	-	5960	4.3
Total Energy Saved	-	-	6320	2.9

Option No. 2 would reduce the first year (1983 dollars) energy expenditure by $32,600. After deducting for first year maintenance costs, the simple payback is 10.2 years and E/C is 28.8.

0.3.4.3 Option No. 3

Option No. 3 would use radio communication as the exclusive method of communication. This option includes all EMCS ST/SP functions in all of the buildings studied which meet the ECIP economic criteria. The EMCS configuration for Option No. 3 consists of a Master Control Room, radio transmitter, radio receiver switches, and a modified software package. The MCR would incude a microprocessor based CCU and a black and white CRT.

The total energy savings for Option No. 3 represents a first year source energy reduction of 5350 x 10^6 BTUs. The energy savings for Option No. 3 are summarized in Table ES.7 on the following page.

TABLE ES.7

ESTIMATED ENERGY SAVINGS OPTION NO. 3

	KW	KWH	10^6 BTU	% OF 1979 ENERGY USAGE
Electrical Energy Saved	136	30,000	-	0.45
Fossil Energy Saved	-	-	5,000	3.6
Total Energy Saved	-	-	5,350	2.5

Option No. 3 would reduce the first year (1983 dollars) energy expenditure by $27,400. After deducting for first year maintenance cost, the simple payback is 7.0 years and E/C is 37.4

0.3.4.4. Summary of Preliminary Economic Analysis

Table ES.8 summarizes the results of the preliminary economic analysis of Options 1, 2, and 3.

TABLE ES.8

SUMMARY OF ECONOMIC ANALYSIS

Option No.	Simple Payback	E/C Ratio
1	12.7	21.5
2	10.2	28.2
3	7.0	37.4

0.3.4.5 Recommended EMCS Configuration

The recommended EMCS configuration (Option No. 1) for Ft. McCoy would utilize telephone lines as the exclusive method of data transmission. The detailed evaluation indicates that a small EMCS, as envisioned by the U.S. Army Corps of Engineers Technical Manual TMS-815-2 for EMCS, would be appropriate for Ft. McCoy. The EMCS would be connected to 88 systems serving 37 buildings, and would have a total of 245 input and output points.

0.3.4.6 Results of Final Analysis

0.3.4.6.1 Final Building List

Buildings which are recommended for inclusion in the proposed EMCS for Ft. McCoy are those with a simple payback period less than 15 years and a E/C ratio of 14 or greater. The buildings which qualify, and the number of systems and input/output points for each building are listed in Table ES.9 on the following page.

TABLE ES.9

BUILDINGS RECOMMENDED FOR EMCS

Building Number	Description	No. of Systems	No. of Points
100	Headquarters Building	4	11
101	Non Commissioned Officers Club	3	8
103	Administration	2	6
106	Administration	1	3
110	Administration	2	6
751	Crafts	3	8
1122	Field House	6	18
1152	Motor Repair Shop	2	6
1463	Motor Repair Shop	4	11
1546	Administration	2	6
1550	Administration	2	5
1555	Fire Station	1	3
1668	Main Exchange	3	9
1868	Exchange Branch	4	11
2016	Administration	3	8
2101	Administration	3	8
2102	Administration	3	8
2110	Motor Pool	5	14
2111	Administration	1	3
2113	Audio Visual Center	1	2
2120	Warehouse	1	3
2121	Warehouse	1	3
2122	Warehouse	1	3
2124	Warehouse	1	3
2125	Warehouse	1	3
2139	Motor Repair Shop	3	8
2160	Administration	3	8
2161	Training Aids	1	3
2168	Administration	2	6
2181	Repair Shop	4	11
2184	Administration	1	3
2197	Arms	1	2
2320	Motor Repair Shop	5	14
2327	Motor Repair Shop	1	3
2672	Chapel	2	5
2846	Motor Repair Shop	3	7
3050	Equipment Concentration Site Repair	2	6
	TOTAL	88	245

0.3.4.6.2 Final Economic Analysis

The proposed EMCS has a simple payback period of 14.8 years, and an E/C ratio of 24.3

The estimated installed cost of the project is $288,500 (1983$). Annual maintenance is predicted to be 5 percent of the contract costs, or $14,000. (Maintenance costs can also be figured as 12% of the material costs.)

The total first year energy savings resulting from implementing this project are estimated to be $33,000.00. The energy savings are summarized in Table ES.10 below:

TABLE ES.10

SUMMARY OF ENERGY SAVINGS

Electricity		Fossil Fuel Saved Btu x 10^6/yr			
kW	kWh/yr	Coal	LPG	Oil	Wood
12	15,780	3836	977	414	1,581

Total Source Energy Saved= 6991 x 10^6 Btu/yr

0.4 BIOMASS AND REFUSE DERIVED FUELS (RDF)

0.4.1 General

Ft. McCoy has approximately 40,000 acres of heavily wooded land, of which 25,000 acres are scrub oak and approximately 15,000 acres are merchantable timber. The scrub oak is available for biomass fuel applications and is the basis for the Ft. McCoy, on-base, forest energy production evaluation. The following is a preliminary evaluation of the feasibility of utilizing biomass type fuels and RDF to displace the non-renewable fuels presently being used.

Direct combustion type processes were emphasized throughout the study, since this maximizes the usefulness of the biomass resources available at Ft. McCoy. Fuel preparation, including drying and pelletizing, was considered, whenever applicable, to upgrade the properties of the fuel.

By contract, the biomass portion of the study presented in this report, is preliminary in nature. A detailed biomass analysis will be presented in a separate report at a later date.

0.4.2 Biomass Potential

There are two sources of biomass fuels available in the Ft. McCoy area. The primary source is the on-base woodlands, which can be systematically managed, harvested and reforested to provide a renewable source of energy. Secondly, there is a substantial forest-products industry throughout the state of Wisconsin and, in

particular, within a 50 mile radius of Ft. McCoy. Typical sawmill wood waste products include sawdust, bark, planer shavings, chips and unmerchantable lumber pieces. The in-forest timber harvesting operations produce slash, over- or under-sized timber, chips and unmerchantable timber. These wood wastes represent a significant renewable energy source of raw material feed stock for biomass conversion programs.

A preliminary study conducted by Ft. McCoy Land Management personnel found potential for utilizing Ft. McCoy timber resources but recommended detailed studies be conducted to establish final design criteria.

0.4.3 Biomass Fuel Systems Applicable to Ft. McCoy

Three forms of wood-related fuels were considered: green wood chips and waste, dried wood chips and waste, and pelletized dry wood waste. Green wood chips and dried woods were eliminated on practical and economic grounds. Various pelletized wood options were considered in detail and these options are described in the sections that follow.

0.4.3.1 Pelletized Wood and Wood Waste

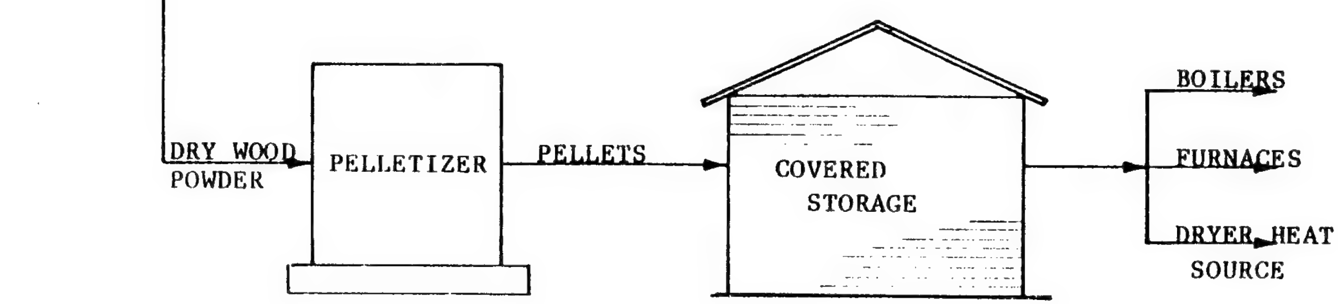
Pelletized wood and wood waste combine the advantages offered by dryed wood fuel with consistent fuel particle sizing and ease of handling. The pelletizing process pulverizes the incoming feed stock, reduces the moisture content of the wood by drying,and then pelletizes the dry, powdered wood into uniformly sized fuel particles. See Figure ES.8 on the following page for a schematic flow diagram. Since the wood is ground to a fine powder prior to pelletizing, the wood fines and sawdust which created combustion problems with other fuel systems are actually beneficial in pelletizing. All forms of wood and wood waste, including decaying timber, can be utilized in the pelletizing process, thereby maximizing the potential source for fuel.

Because of the high bulk density and high heating value of the pellets, they can be used in place of coal in boilers and furnaces with minimal modifications. Coal storage bins and handling equipment generally can be utilized; however, their handling capacity will be derated by a factor of approximately 2.5 due to the difference in bulk densities and heating values. When wood pellets are used, greater operational care is necessary for protection of the grates.

Because the wood pellets can improve the operation of existing coal boilers and do not present substantial differences in methods of material handling, they were used as the alternate biomass fuel source in the economic life cycle cost evaluation of this study.

FIGURE ES.8

WOOD PELLETIZING PROCESS FLOW



0.4.4 Economic Feasibility of Using Biomass

The on-base forest energy potential was estimated at 43.6×10^9 BTU/YR and the off-base energy potential at 420×10^9 BTU/YR. The on-base forests would permit Ft. McCoy coal usage to be displaced with wood pellets in the following areas:

- The nine (9) boilers currently fueled with wood pellets.
- The base hospital boiler (This boiler has been fired with wood pellets this past year).
- Additional boilers and furnaces having a combined fuel input of approximately 16.0×10^9 BTU/YR or 390 tons of coal per year.

The off-base forest energy potential could displace all coal presently being used at Ft. McCoy. It is estimated that the FY 1979 Ft. McCoy coal usage (boiler fuel input basis) was 83.7×10^9 BTU/yr, with off-base wood energy potential estimated at 420×10^9 BTU/yr.

Based upon the desirability of maximizing the fuel contribution by Ft. McCoy's on-base forests, the fuel quantity used in the development of preliminary economic feasibility and life cycle costs was assumed to be the maximum amount that the Ft. McCoy forests could supply on a continuously renewable basis (43.6×10^9 BTU/YR or 10,000 tons per year of scrub oak).

The economic feasibility of biomass utilization was evaluated using the life cycle cost method. The following five (5) alternate sources of fuel were considered in the evaluation:

- Wood pellets <u>purchased</u> from the current supplier in Tennessee and shipped to Ft. McCoy.
- Wood pellets <u>purchased</u> from supplier in the Great Lakes area and shipped to Ft. McCoy.
- Wood pellets <u>produced</u> at Ft. McCoy utilizing Ft. McCoy scrub oak wood supplies.
- Wood pellets <u>produced</u> at Ft. McCoy utilizing off-base wood supplies.
- Stoker coal as <u>purchased</u> from the present Ft. McCoy supplier (base case).

Fuel cost data, Table ES.11 on page ES-36, was developed on an energy output basis to illustrate the cost per million BTU of the various wood fuels, coal LPG and oil. These figures can be used to compare BTU heating values of other fuels to those of biomass fuels.

The preliminary life cycle costing was developed using September, 1980 cost data with no cost adjustments for Project Anticipated Midpoint of Construction Date and Beneficial Occupancy Date (BOD) included into the calculation. The cost adjustments were excluded due to the preliminary nature of the cost data. Life cycle costs were developed for the four wood alternatives, coal, LPG and oil. Coal was assumed to be the base case for comparative life cycle evaluation.

The results are summarized in Table ES.12 on page ES-37. The life cycle costs of the wood alternatives varied from $4,206,000 for an on-site pelletizing operation using on-base wood to $4,776,000 for wood pellets purchased from Tennessee. The life cycle cost using coal is $4,177,000. Life cycle costs for using LPG or No. 2 fuel oil are $7,890.000 and $7,639,000 respectively.

TABLE ES.11
ECONOMIC SUMMARY

FUEL COSTS - BASED ON HEATING PLANT OUTPUT

METHOD OF BIOMASS USE	CAPITAL RECOVERY FACTOR COST*	OPERATIONAL COST **	TOTAL COST ***
Wood Pellets Purchased from Tennessee	$0.55/10^6$BTU	$10.54/10^6$BTU	$11.09/10^6$BTU
Wood Pellets Purchased from Great Lakes Area	$0.55/10^6$BTU	$ 9.91/10^6$BTU	$10.46/10^6$BTU
Wood Pellets Produced at Ft. McCoy, on-base wood	$2.48/10^6$BTU	$ 8.25/10^6$BTU	$10.73/10^6$BTU
Wood Pellets Produced at Ft. McCoy, off-base wood	$2.48/10^6$BTU	$ 9.02/10^6$BTU	$11.50/10^6$BTU
Coal	0	$10.55/10^6$BTU	$10.55/10^6$BTU
LPG	0	$13.14/10^6$BTU	$13.14/10^6$BTU
No. 2 Fuel Oil	0	$14.53/10^6$BTU	$14.53/10^6$BTU

* Capital Recovery Factor Costs: Developed with a capital recovery factor of 11.017% based upon 10% discount factor over a 25 year period. This cost includes interest and principal costs.

** Operational Costs: Include fuel costs, transportation costs, fuel and ash handling costs, and continuing maintenance costs prorated over a 25 year period. No cost escalation factors or differentials have been applied.

*** Total Cost = (Capital Recovery Factor Cost) + (Operational Cost)

All costs are stated in September, 1980 dollars.

TABLE ES.12

PRELIMINARY

LIFE CYCLE COST ANALYSIS*

	Wood Pellets Purchased From Tenn.	Wood Pellets Purchased From Great Lakes Area	Wood Pellets Produced With On-Base Wood	Wood Pellets Produced With Off-Base Wood	Coal	LP GAS	NO. 2 Fuel Oil
Initial Cost	$ 174,000	$ 174,000	$ 784,000	$ 784,000	0	0	0
Operating and Maintenance Cost	$4,602,000	$4,279,000	$3,422,000	$3,821,000	$4,177,000	$7,490,000	$7,639,000
Total Life Cycle Cost	$4,776,000	$4,453,000	$4,206,000	$4,605,000	$4,177,000	$7,490,000	$7,639,000
Percentage Deviation from Coal LCC.	(+)14.3%	(+) 6.6%	(+) 0.7%	(+)10.2%	0	(+) 79.3%	(+) 82.9%

* Based on Heating Plant output using 10,000 tons of wood

0.4.5 Refuse Derived Fuels Potential

0.4.5.1 Solid Waste

The energy potential from the solid wastes generated on-base at Ft. McCoy was evaluated for both technical and economic feasibility. Ft. McCoy generated approximately 39,533 cubic yards of solid waste during FY 1979. Approximately 9117 cubic yards per year or an average of 760 cubic yards per month of the total solid waste is considered combustible material, suitable for Refuse Derived Fuel (RDF) energy production applications. The remainder of the solid waste is composed of materials which require extensive preparation prior to combustion; furthermore, the supplies are seasonal, not steady. Hence, this material requiring pre-combustion preparation was not included as a source of potential fuel in this report.

Highly combustible waste, however, such as paper, cardboard, cartons, etc., is available for energy production 12 months per year and were considered as the basis for the solid waste conversion- to-energy evaluations in this report.

0.4.5.2 Description of Solid Waste Combustion Process

The methods of conversion of solid waste into heat energy normally involve direct combustion type processes or adaptations such as gasification or pyrolysis processes. Pyrolytic incineration with heat recovery represents the most feasible process for the volume and type of solid waste available at Ft. McCoy. The equipment is commercially available and the technology operationally proven. The typical pyrolytic incinerator installation includes primary and secondary combustion chambers connected to a waste heat boiler designed to convert the high temperature products of combustion (2200° F) to usable heat energy. Pyrolysis of the solid waste takes place in the primary combustion chamber with combustion of the products of pyrolysis taking place in the secondary combustion chamber. This type of equipment, of the size range applicable to Ft. McCoy, utilizes batch type feed systems rather than the continuous feed systems found on installations processing much higher volumes of solid waste. Batch feeding requires a 24 hour per day equipment operator capable of loading approximately 200 lb/hr of solid waste into the incinerator.

0.4.5.3 Results of Solid Waste Analysis

The life cycle costing was developed using September, 1980 cost data with no cost adjustments for Project Anticipated Midpoint of Construction Date and Beneficial Occupancy Date (BOD) included in the calculation.

These cost adjustments were excluded due to the preliminary nature of the cost data. The life cycle cost comparison of coal, wood pellets and pyrolytic incineration was evaluated on the basis of heat output from the boilers.

The comparison of life cycle costs are summarized on Table ES.13 shown below.

TABLE ES.13

LIFE CYCLE COST ANALYSIS OF SOLID WASTE ENERGY POTENTIAL

	EXISTING BOILERS USING COAL (BASE CASE)	EXISTING BOILERS USING WOOD PELLETS	SOLID WASTE FIRED PYROLYTIC INCINERAT
Initial Cost	Ø	$ 26,000	$ 70,000
Operation and Maintenance*	$623,000	$690,000	$1,160,000
Total Life Cycle Cost	$623,000	$716,000	$1,230,000
Percentage Deviation From Base Case LCC.	---	(+)15%	(+) 97%

* Coal fuel costs based upon 294 tons @ 12,290 Btu/lb. for boiler output of 5.23×10^9 Btu/year.

Wood pellet fuel costs based upon 467 tons @ 8000 Btu/lb for boiler output of 5.23×10^9 Btu/year. (Pellets purchased from "Woodex" in Tennessee)

Additional operating personnel are assumed for pyrolytic incinerator operation

0.4.5.4 Liquid Waste

0.4.5.4.1 Waste Oil Utilization

Waste oil has been collected from the maintenance operations at Ft. McCoy and used as a boiler fuel since March, 1980. The total annual quantity of waste oil available is approximately 12,000 gallons.

0.4.5.4.2 Waste Oil Preparation

The waste oil, as described in the Ft. McCoy Report, has characteristics similar to those of No. 5 fuel oil; but, as a waste product, it may contain sludge, water and oil additives. The sludge and the water can normally be removed or their concentrations reduced to levels that do not harm combustion properties. This can be done by:

- Heated settling tanks
- Filtration using mechanical filters.
- Filtration using chemical packed-bed filters.
- Addition of moisture scavenging chemicals which react with the water to form burnable soluble compounds.

Heated settling tanks will normally be adequate and the most cost effective.

The presence of oil additives, such as corrosion inhibitors, anti-oxidants, detergents and anti-foaming chemicals may cause combustion related problems within the boiler. Typical samples of the waste oil should be tested to define what oil additives are present. The boiler manufacturer should be asked what effect the additives may have on the boiler's refractory, heat transfer surfaces and exhaust stack lining. If the additives are harmful to boiler components, the waste oil may require the addition of chemicals to neutralize the original oil additives.

It is evident from the experience gained at Ft. McCoy, that with minimal equipment modifications, waste oil can be fired successfully without any pre-treatment, and with significant cost savings. However, there presently is

federal legislation* under consideration which would not allow the combustion of waste products such as waste oil and similar materials in conventional boilers or furnaces without re-refinement. The legislation is primarily designed to limit the uncontrolled emissions of toxic or harmful chemicals into the atmosphere but could be applied to the combustion of waste motor oils.

0.5 ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) PROJECTS

0.5.1 General

The ECOs described in Section 0.3 of this Summary have been combined to form energy conservation projects based on guidance received from Ft. McCoy facilities engineering personnel.

0.5.2 Method of Analysis

Initially, only those ECOs meeting ECIP criteria were included in the project formulation. If more than one ECO was initially included in a project, the ECOs were retained in the project as long as the overall project E/C ratio and payback period were within the ECIP acceptance criteria, i.e., E/C of 14 or greater and a payback period within the economic life of the ECO. If the project E/C and payback period did not fall within the criteria, due to the interrelationship effect of the various ECOs, the ECO having the lowest E/C (or least desirable) was eliminated and the project was reevaluated. The projects were also evaluated in order of desirability, and the interrelationship between projects, if any, has been accounted for.

0.5.3 Description of Projects

Prior to analyzing the effects of ECO interrelationships, ECOs were grouped into the following projects:

0.5.3.1 Project 1

The ECOs are listed in descending order of their respective E/C ratios.

ECO Number	Description
8)	Truck door insulation
1)	Caulk windows
4)	Weatherstrip doors and add vestibules
6)	Insulate windows
7)	Add insulation where required

*Energy User News, Monday, May 19,1980

2)	Add storm windows where required
3)	Add interior storm windows in addition to exterior storm windows
5)	Storm doors

0.5.3.2 Project 2

ECO Number	Description
Option No. 1	Energy Monitoring and Control System
15	Auto day and night setback (local loop controls)
16	Improved stoker control (local loop control)
17	Outside air reset control on hot water boilers (local loop control)

0.5.3.3 Project 3

ECO Number	Description
18	Domestic hot water (barracks), steam supply and condensate piping insulation.

0.5.3.4 Project 4

ECO Number	Description
19	Showerhead flow restrictors

0.5.3.5 Project 5

ECO Number	Description
13	Improved efficiency (flue gas condensing type) gas furnaces and domestic water heaters.

0.5.3.6 Project 6

ECO Number	Description
14	Ceiling fans in buildings with high bay or very high ceilings.
28	Replace mercury vapor metal halide and incandescent lighting with high pressure sodium lights in buildings 1122, 1152, 1463, 2320 and 3050.

0.5.3.7 Project 7

ECO Number	Description
24	Discontinue use of the central boiler in the hospital area during times of low building utilization or when space heating is not required.

0.5.4 Results of Project Analysis

The ECOs listed in Table ES.14 on the following page, were eliminated from projects when, after interrelationship effects were accounted for, it was determined the energy savings did not meet ECIP requirements. Only part of ECO number 18, "Insulate Hot Water, Steam and Condensate Piping", is recommended for implementation. Revised cost estimates for installing insulation on the domestic water piping in the barracks (occupied in summer only) put the E/C ratio and payback periods outside the ECIP criteria. Insulating the supply steam piping (located in the heated space) is not cost effective if an EMCS or local controls are installed, because the controls will reduce the overheating problem currently caused by the uninsulated piping. The new controls simply shut a valve in the main supply line when the occupied space temperature goes over the setpoint, i.e., 65° F during occupied hours and 55° F during unoccupied hours. The steam condensate piping, located exterior to the heated space and the domestic water piping in BOQs occupied 12 months a year should be insulated and is included as an ECIP project. Similarly, the flue gas condensing domestic water heater, a portion of project 5, does not meet ECIP criteria after flow restrictors are added to the buildings. Therefore, only the furnace portion of the project is recommended for implementation.

TABLE ES.14

ECOs ELIMINATED FROM PROJECTS

ECO NO.	DESCRIPTION	REASON FOR ELIMINATION
3	Triple Glaze Windows	Insufficient energy savings
5	Storm Doors	Door weatherstripping is more cost effective than storm doors.
6	Insulate Windows	Insufficient energy savings
13	Flue-gas condensing domestic water heaters	Insufficient energy savings after flow restrictors are installed
18	Insulate steam supply piping and domestic water piping (in barracks)	Insufficient energy savings after EMCS is implemented
28	Replace lighting in buildings No. 1463, 2320, and 3050	Insufficient energy savings in Buildings 1463, 2320 and 3050.

The ECOs remaining in the projects after these ECOs were deleted, and on which the costs and energy savings are based are listed below:

Project 1

ECO Number	Description
8)	Truck door insulation
1)	Caulk Windows
4)	Weatherstrip doors and add vestibules
7)	Add insulation
2)	Add storm windows

Project 2

ECO Number	Description
Option No. 1	Energy Monitoring and Control System
15	Auto day and night setback (local loop control on those buildings not recommended for EMCS)

Project 3

ECO Number	Description
18	Insulate condensate return piping and domestic water piping which is located in mechanical rooms, of BOQs occupied 12 months per year.

Project 4

ECO Number	Description
19	Showerhead flow restrictors

Project 5

ECO Number	Description
13	Improved efficiency (flue gas condensing) type furnaces

Project 6

ECO Number	Description
14	Ceiling fans in buildings with high bay areas
28	Replace incandescent lights in Building 1122 (gymnasium only) and replace Mercury vapor lights in Building 1152

Project 7

ECO Number	Description
24(c)	Discontinue use of central plant boiler in hospital area during times of low building utilization or when space heating is not required (Option C)

Energy savings for the seven projects were determined. The energy savings, simple payback, E/C ratio and total estimated project costs are summarized in Table ES.15 on page ES-48. The energy savings resulting from implementing all of the recommended projects are shown graphically in Figure ES.9 on page ES-47.

The effects of implementing the energy conservation projects (in comparison to FY 1979 utility bills) are summarized in Table ES.16 on page ES-49. If all projects are implemented, the electrical energy consumption will be reduced approximately 2.6 percent, while the overall thermal energy consumption will be reduced 40.0 percent. The total cost for all seven projects is estimated to be $1,869,000, giving an overall simple payback period of 5.1 years and an overall E/C equal to 33.8.

In addition to the seven original projects, project number 8 was added to the projects list. Project number 8 was formulated after the Preliminary Report Review Conference. The project is described below:

Project 8

Description

Beginning in the winter of 1981/82 there will be winter AT training at Ft. McCoy. Therefore, a project for winterizing the buildings which are planned for this use is being considered. The winterization program includes: caulking, weatherstripping, adding storm windows, insulation and vestibules where appropriate. The ECOs for this project are similar to those in Project No. 1

Since project number 8 involves energy savings which will not be reflected in the base energy year (FY 1979), it is being treated differently from the other projects, i.e., implementation of projects 1 through 7 will show savings in comparison to FY 1979 where project 8 will not. Therefore, the cost avoidance, energy savings and implementation cost are summarized in Section 0.5.5. The total estimated cost for project 8 is approximately $1,539,000 with a simple payback period of 10.6 years and an E/C ratio of 27.6.

FIGURE ES.9

ENERGY SAVINGS FOR ALL PROJECTS

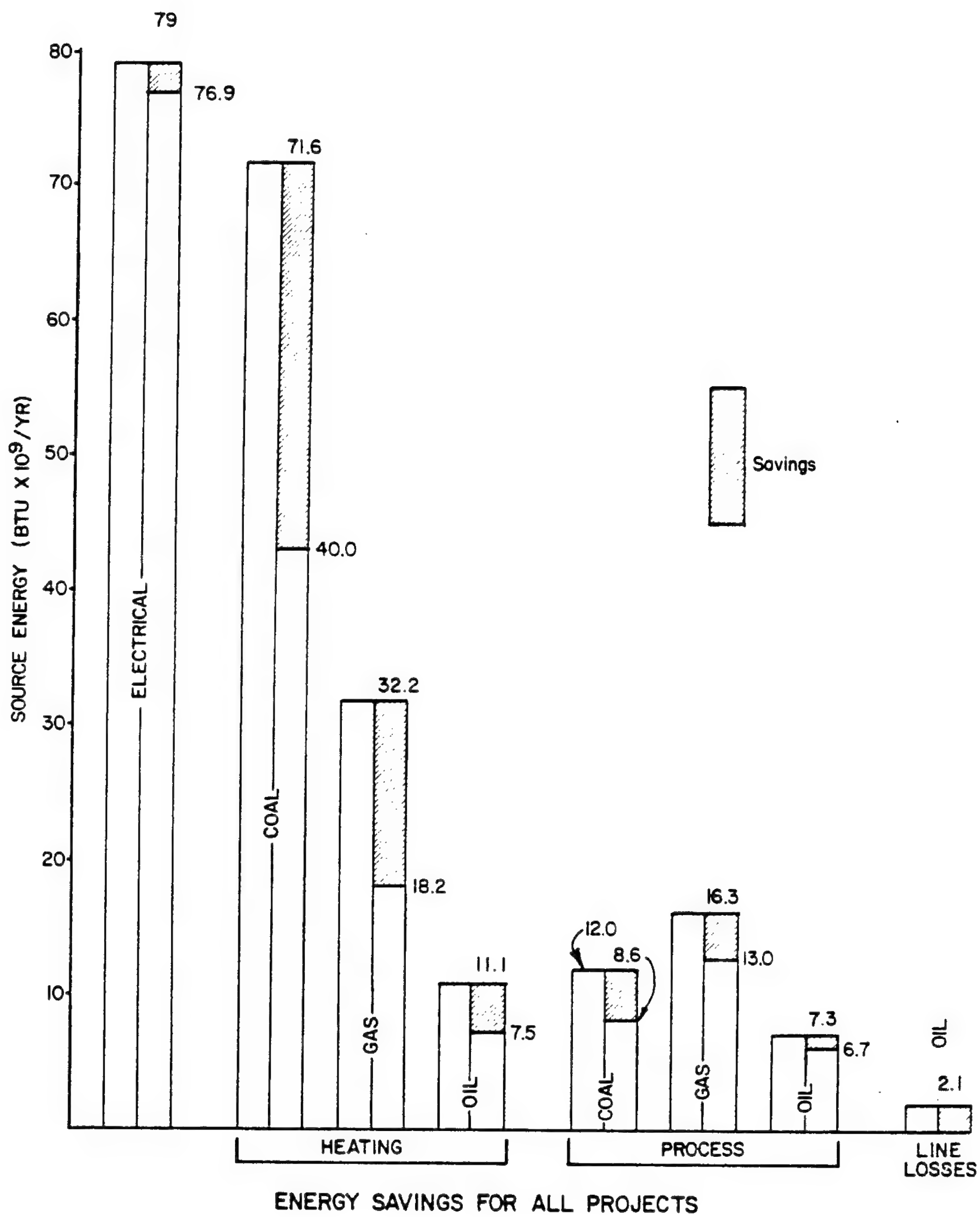


TABLE ES.15

SUMMARY OF PROJECT ENERGY SAVINGS

Project No.	ELECTRICAL Demand (kW)	Energy (Btux6)	THERMAL (Btu x 10^6/yr) Coal	Oil	LPG	Wood**	Total Btu Saved (rounded)	Total Dollars Saved (rounded)	CWE (1983$)	SIMPLE PAYBACK (YRS)	E/C
1	-	5	15,600	2,520	8,740	3,140	30,000	174,000	973,000	5.6	30.8
2	12	275	4,120	499	1,380	1,580	7,850	26,000	339,000	13.0*	23.2
3	-	-	5,560	615	928	920	8,020	36,200	97,700	2.7	82.1
4	-	-	3,430	620	3,350	-	7,400	49,500	73,500	1.5	101
5	-	-	-	-	4,040	-	4,040	40,700	227,000	5.6	17.8
6	15	1,740	581	-	-	141	2,460	12,600	65,900	5.2	37.3
7	-	-	-	4,480	-1,120***	-	3,360	29,400	111,000	3.8	30.3
Rounded Totals	27	2,020	29,300	8,730	20,000	5,780	67,100	369,000	1,869,000	5.1*	33.8

* Includes cost for increased maintenance (EMCS)

** Wood savings are included since Ft. McCoy is now using wood pellets in several boilers, although during the base year (FY 1979) wood was not used except on an experimental basis.

***Negative number indicates increase in fuel usage.

TABLE ES.16

SUMMARY OF ENERGY REDUCTIONS RESULTING FROM PROJECT IMPLEMENTATION

PROJECT NO.	PERCENTAGE REDUCTIONS IN: ELECTRICAL	COAL AND WOOD	OIL	LPG
1	0	22.4	12.2	18.0
2	0.35	6.8	2.4	2.8
3	0	7.7	3.0	1.9
4	0	4.1	3.0	6.9
5	0	0	0	8.3
6	2.2	0.9	0	0
7	0	0	21.8	-2.3*
TOTALS	2.6	41.9	42.4	35.7

* A negative number in Table ES.16 denotes an increase in fuel usage.

0.5.5 Effects of Implementing Project 8

Beginning in the winter of CY 1981/82 Ft. McCoy will be used for winter AT training. Since the majority of the barracks, mess halls and maintenance shops have historically been used primarily in the summer months, the buildings are not properly winterized. Therefore, a winterization program was considered. Since there is no history of building usage for this program, assumptions were made as to anticipated building utilization. The assumptions used in the analysis were as follows:

- o The buildings will be used for six, two-week sessions.
- o Approximately 2,000 troops will be involved in the first year winter training.
- o First year usage will be during January, February and March of 1982.
- o The barracks will be unoccupied during the days (troops will be in the field) and occupied at night only, 7 nights out of the two week session. Mess halls and administation buildings will be used during the full 14 days of the session.

The results of the analysis are summarized in Table ES.17 below.

TABLE ES.17

ENERGY SAVINGS RESULTING FROM PROJECT 8 (Btu x 10^6/yr)

DESCRIPTION	Energy Savings (Btu x 10^6/yr) Coal	Oil	Total	Cost Savings ($)	CWE (1983$)	Simple Payback (yr)	E/C (kBtu/$)
Caulk, Weather-strip, add insulation, add vestibules, add storm windows	35,900	2,500	38,400	128,000	1,407,000	11.0	27.3
Local loop controls (night setback thermostat and time clock)	305	49	354	1,340	17,000	12.7	20.8
Steam supply and condensate insulation	3,030	694	3,730	15,200	115,000	7.6	32.4
TOTALS (Rounded)	39,200	3,240	42,500	145,000	1,539,000	10.6	27.6

0.5.6 Recommendations

0.5.6.1 ECIP Projects

All of the final ECIP projects described in Section 0.5.4 are recommended for implementation. Project documentation has been prepared for these projects and is included as Volume IV of this report.

0.5.6.2 Biomass and RDF

Based on the preliminary life cycle cost analysis of the potential for using biomass fuels at Ft. McCoy, it was recommended that a more detailed analysis and cost estimate be made prior to rejecting or implementing the project. This effort is presently being accomplished. The results will be provided in a separate report.

On the other hand, the preliminary analysis of the potential for using solid waste as fuels at Ft. McCoy showed that in comparison to using coal, it is clearly not cost effective and therefore does not warrant further study or implementation at the present time.

Waste oil utilization has the potential for significant energy savings. Facility engineering personnel should stay abreast of legislative developments regarding the use of waste oil as fuel.